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LAND SHELLS OF NAVASSA ISLAND, WEST INDIES

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WITH SEVEN PLATES

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No. 5 -- *Land Shells of Navassa Island, West Indies*

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No study of the mollusks of Navassa Island has been made since 1866 when only a few dead specimens were available. This paper is based on a large series of preserved material which has made it possible to determine the relationships of these mollusks to those of other islands in the West Indies.

Navassa is a small, isolated island located about 40 miles west of the Tiburon Peninsula of Haiti and about 85 miles northeast of Morant Point, Jamaica, at north latitude  $18^{\circ} 25'$  west longitude  $75^{\circ} 05'$ . It is an elevated coral reef of about 1.5 square miles in extent, one and one-fourth miles at its longest point, and with an elevation of 250 feet at its highest point. It is pear-shaped in outline and in profile is said to look like a huge battleship with the lighthouse for a mast, or a gigantic straw hat with a low, flat crown. The island rises abruptly from fairly deep water, the depth at the shoreline averaging about 12 fathoms. On all except the north coast there is a deep undercut at the water level. The sea cliffs average about 40 feet in height above which there is a bench of some 100 yards in width and then a steep slope which leads to the rather flat crown. The width of the bench varies somewhat, being very narrow at the northwest point but widening gradually toward the south and east. The island is virtually inaccessible from the sea and today is 'boarded' by climbing a chain ladder which hangs from the cliffs at Lulu Bay on the lee side. The entire surface of the limestone island is pitted with holes varying from five to more than forty feet in depth and from a foot to several yards in diameter. As a result, though the island receives a fair rainfall, it is physiologically dry. There are no ponds and frequent drilling of wells has never produced any fresh water, for all rain water is rapidly drained off by the numerous fissures and caves. This type of terrain makes walking on the island most difficult and W. J. Clench (1930) wrote, "Most of our excursions consisted of a long series of jumps from the rim of one hole to that of another," and he says that it could take as long as four hours to walk a mile.

The island of Navassa was practically unknown until 1857 when Captain E. K. Cooper of Baltimore, Maryland, and Peter Duncan discovered the phosphatic guano deposits while making soundings around the island. They took possession of the uninhabited island and worked the deposits for a time before the formation in September 1864 of the Navassa Phosphate Company of New York, of which E. K. Cooper was a member of the executive council. The reports to the company in 1864 of Dr. G. A. Liebig, chemist, and Augustus H. Fick, mining engineer, gave an excellent picture of the rich phosphate deposits and of the condition of the island at that time. In November 1865 Eugene Gaussoin, mining engineer and metallurgist, sailed from Baltimore on the company brig with the vice-president of the company and Peter Duncan, captain, to visit the island. The purpose of his visit was to advise the company on means of finding water, improving mining techniques, shipping facilities and other matters. In his report, he wrote that at that time there were "30 white men, officers and mechanics, and 180 black laborers" on the island and all food, water and other supplies had to be shipped in from great distances — a formidable task! However, the company was reasonably successful for a time, though working under great difficulties, but in 1898, during the Spanish-American war, the company failed and the island was abandoned. During World War I a detachment of marines was stationed there for a time. With the building of the Panama Canal, the amount of shipping through the Windward Passage increased greatly and it became most important to have a lighthouse on the island to protect shipping from this treacherous rock rising out of the sea. The lighthouse was completed in October 1917 and from that time until 1929, when the light was made automatic, the island was inhabited by the three families who attended the light. Again during World War II the island was garrisoned by American troops. Today, the island is uninhabited and is seldom visited except by members of the U.S. Coast Guard who service the light, and occasional hunters who go there to shoot wild goats — descendants of those left by the lighthouse keepers.

Though few biologists have ever visited the island, the flora and fauna are now quite well known and are remarkable for the

number of endemic species in several phyla which occur on such a small area. In December 1929, W. J. Clench visited the island and later wrote, "It is a bird island and thousands of boobies were nesting all over the place, in the small trees, on the low bushes and even among the low vegetation. A few frigate birds were also nesting and to see these beautiful birds close at hand was a royal experience." Wetmore and Swales (1931) listed 20 species of birds from Navassa of which one, the Navassa ground dove, is peculiar to the island.

In July 1917, R. H. Beck collected there for the American Museum of Natural History, and from this collection of reptiles K. P. Schmidt (1919, 1921) described a new genus and five new species of lizards, all endemic. He listed 13 species from the island and related them to species found in Jamaica, Hispaniola and Cuba. Cope (1886) described an iguana, probably collected by Gaussoin, but this large lizard has apparently been extinct for a long time; it was undoubtedly exterminated by the laborers working the phosphate deposits who would have used it for food. Proctor (1959) states that "no less than 10 endemic species of lizards have been reported."

In an excellent paper on the flora of Navassa Island, E. L. Ekman (1929) wrote, "needless to state, this vegetation, for all its freshness in the rainy season, is well suited to survive even the severest of droughts. The roots of the trees like the *Ficus* penetrate into the rock fissures to astonishing depths. The *Mctopium* sheds, if necessary, all its leaves in winter. The savanna plants belong to different types of xerophytes. The cacti are succulents, the grasses and the sedges survive by means of their drought- and fire-resisting rhizomes, and the weeds defy the dry season here in the same way as they do the winter in the north. The unproportionately great number of annuals on Navassa, c. 30, or about 33 per cent of the total number of plants, bear mute witness to the efficacy of their means of protection." An interesting and rather surprising thing about the flora of Navassa is the almost complete lack of halophytes, for only two species can be classed as such. Ekman listed 102 species of vascular plants for the island, 44 of which are probably indigenous and 8 species and two varieties are endemic.

Only three species of land shells are known from this small island and these were all described by George Tryon in 1866. He had received a small series collected by Eugene Gaussoin, the mining engineer mentioned above. His collecting, however, was casual and all of the material was dead and worn. As a result, the systematic position and island relationship of these species have remained uncertain.

In December 1929 a Harvard University Expedition, led by William J. Clench accompanied by William E. Schevill and Harald A. Rehder, visited the island. They landed December 29, and spent two weeks of intensive collecting of all groups of plants and animals. This was during the dry season and the land shells were probably not as active as at other times so that it was necessary "to move and turn over several tons of rock before sufficient numbers were secured for study." A single pupillid was found the day they arrived while they were laboriously carrying their supplies up the steep slope to the lighthouse quarters where they were going to live. Not having a proper container available the minute specimen was placed in a match box and unfortunately it fell out and was lost. Continued intensive search failed to turn up another specimen. It is possible that collecting on the island during the rainy season might add to the known molluscan fauna. As a result of this collecting we are now able to show that two of the three species of land shells, all of which are endemic to the island, are related to species in Jamaica, one to Haiti.

Considering the unreceptive shores of Navassa, its undercut and precipitous rocky cliffs, it would be virtually impossible for any plant or animal, with the possible exception of lizards, to reach the island by rafting. Consequently, whatever the population (excluding those species introduced by man), it seems safe to conclude that the original species were carried there by hurricanes. The large number of endemic species on the island would suggest that it is old and has been isolated for a very long time. Versey (in Proctor, 1959), reporting on the Foraminifera, stated that "the micro-facies appear to be very similar to that encountered in the Pliocene Coastal Limestones of the North Coast of Jamaica. The only foraminifera present are *Opereulinoides* and *Heterostegina*, both of which range from Eocene to Recent. The age of the limestone probably lies within the range Miocene-Recent."

It is also possible, of course, that these species have differentiated rapidly as may happen in small isolated populations. Whatever the factor involved — long isolation or rapid evolution — the molluscan species are all well differentiated.

Since Tryon had only a few dead and worn specimens at the time he described these species he could not give the range of variation nor even describe them completely. Consequently they are redescribed here.

### EUTROCHIATELLA CIRCUMLINEATA Tryon

Plate 1, figs. 1-3; Plate 7, figs. 3-5

*Helicina circumlineata* Tryon 1866, American Journal of Conchology, vol. 2, p. 305, plate 20, fig. 13 (Navassa Island).

*Description.* Shell trochoid, reaching 11.5 mm. in height, solid, heavy, imperforate, pale ivory to salmon in color and sculptured with spiral cords. Whorls 6 and slightly convex. Suture slightly impressed. Spire conic and produced at an angle of about  $77^\circ$ . Columella short, nearly straight and curving into the basal lip. Aperture oval and cast at an angle of about  $55^\circ$  from the base. Outer lip simple, not reflected. Inner lip consisting of a thinly glazed area on the body whorl. Sculpture consisting of numerous, fine, evenly spaced spiral threads. There are about 32 on the body whorl, those above the periphery being slightly coarser and more widely spaced than those on the base. Color ranging from a pale ivory to salmon, the body whorl usually lighter in color than the earlier whorls. Parietal area and lip white. Interior of the aperture a medium to rather deep orange. Embryonic whorls  $1\frac{1}{4}$ , very small, smooth and white. Operculum subquadrate with a thin chitinous base and a well developed calcareous outer surface which has a thickened ridge on the parietal margin. Nucleus near the parietal margin, growth lines concentric. Color of the operculum ranging from orange to salmon, becoming lighter as the calcareous deposit thickens near the parietal margin.

height	width	
9	9.5 mm.	all adult specimens
10	11.5	
10.5	11.5	
11	11	

*Types.* The holotype is in the Academy of Natural Sciences, Philadelphia, from Navassa Island, collected by Mr. Eugene Gaussoin.

*Remarks.* Tryon described this species from two dead, bleached specimens and he did not see the operculum. The present series shows a variation in color from light ivory to salmon. The operculum is similar to that of other species placed in this genus and the radula fits well within the range of variation for the genus *Eutrochatella* as given by H. B. Baker (1922). However, it seems to combine the characters of his subgenus *Troschelviana* (type species *Helicina erythraca* Sowerby) and the subgenus *Eutrochatella* (type species, *Helicina pulchella* Gray). The lateral teeth of *E. circumlineata* have large, well developed cusps as in *erythraca* but the marginals are very numerous as in *pulchella*. In addition, the large fourth lateral (called the T-lateral by Baker) of *circumlineata* bears a number of well developed cusps as in *erythraca*. This tooth in the subgenus *Eutrochatella* as given by Baker is smooth or nearly so.

This species seems to be most closely related to *Eutrochatella costata* Sowerby from the vicinity of St. Ann's Bay, Jamaica, but differs in being considerably larger though less coarsely sculptured. The radulae of *circumlineata* and *costata* are also nearly identical, both species having numerous marginals and denticulate laterals.

In his field notes, Dr. Clench stated that *circumlineata* was found "mostly under stones and flat limestone slabs. They were found in quite barren areas under the top layer of loose flattish stones and were moderately abundant."

#### CHONDROPOMA (CHONDROPOMA) NAVASSENSE Tryon

Plate 1, figs. 4-7; Plate 2; Plate 7, figs. 7-9

*Chondropoma navassense* Tryon 1866, American Journal of Conchology, vol. 2, p. 305, pl. 20, fig. 12 (Navassa Island).

*Chondropoma (Chondropoma) navassense* Tryon. Henderson and Bartsch 1920, Proceedings United States National Museum, vol. 58, p. 62.

*Description.* Shell reaching 20 mm. in length (truncated specimen) rather thin in structure but strong and finely sculptured. Spire extended, truncate except in very young specimens,



and produced at an angle of about  $32^\circ$ . Umbilicus small, extending to the embryonic whorls, and nearly covered by the reflected lip in adult specimens. Color a uniform dull yellowish brown. Interior of aperture a shiny yellow-brown, lip white. Whorls remaining 4 to 5, and moderately convex. Suture moderately impressed with, in some specimens, a shallow channel on the body whorl which increases slightly in width and depth toward the aperture. Aperture subcircular. Outer lip simple, very slightly reflected and with a small angular projection in the region of the anal canal. Inner lip narrow, simple, not appressed against the body whorl and partially covering the umbilicus. Axial sculpture consisting of numerous, fine, more or less evenly spaced ridges. Spiral sculpture consisting of evenly spaced threads of about the same strength giving a rather uniform reticulated pattern. Small nodules are produced where the ridges and threads cross. Umbilicus bordered by 3 or 4 prominent spiral cords. Operculum subcircular, paucispiral and with a thin granular calcareous deposit on the outer surface.

height	width	
20	20 mm.	adult, truncated specimen
15.5	10	“ “ “

*Type.* The holotype is in the Academy of Natural Sciences, Philadelphia, collected by Eugene Gaussoin. The type locality is Navassa Island. Paratype in the Museum of Comparative Zoology no. 78164, received from Mr. Tryon.

*Remarks.* The original description of this species was based upon five dead specimens; in fact, Tryon was not sure of the color of the shell and he did not see the operculum. To my knowledge no additional collections of this species were made until Navassa was visited by W. J. Clench, W. E. Schevill and H. A. Rehder in 1929-30. In his field notes Dr. Clench wrote that these snails were "most abundant under rocks, especially 200 to 300 feet N.W. of the lighthouse. They were quite abundant in the tufts or clumps of grass about the roots and adjacent edges of stones. On the S.E. side of the island many were found climbing trees to a height of 5 to 6 feet and aestivating in protected nooks about the roots or on the branches."

As a result of this collecting we are now able to figure the operculum and the radula in addition to gaining an understanding of the range of variation within the species. On the basis of the rather large series collected, this species appears to be remarkably uniform in color for this group, there being no evidence of any color pattern, and all specimens being a uniform yellowish brown. The variation in size and proportions is also within rather narrow limits, the greatest variation coming in the amount of truncation.

This species is probably most closely related to *Chondropoma* (*Chondropoma*) *brownianum* Weiland from Gonave Island, Haiti. However, it is readily differentiated by its uniform color, the striking but variable color pattern of *brownianum* consisting of axial bands of red brown on a pale buff ground color. These bands may be entire, interrupted or in the form of triangular spots, and the intensity of the color may also vary considerably. *Chondropoma* (*C.*) *molense* Bartsch from the Le Mole River on the northern peninsula of Haiti and *Chondropoma* (*C.*) *montalbense* Bartsch from Coteaux on the southern peninsula are also closely related. In fact, these last two species seem to be at best only subspecies of *brownianum*. The size, sculpture and shape of the aperture of all are very similar.

The radula of *navassense* shown in Plate 7, figure 9 is similar to that shown by Hidalgo (1947) for species in the related genus *Chondrothyra*, except that the denticles on the second laterals are well developed in *navassense* whereas on the second laterals of *Chondrothyra* the denticles are lacking entirely or are very small. The radula of *navassense* is almost identical to that shown by H. B. Baker (1924) for *Tudora*.

*Chondropoma navassense* feeds on the thin coating of grayish lichens on the bark of the bushes, trees and rocks. Their feeding tracks are shown, greatly enlarged, on Plate 2.

#### ZAPHYSEMA (ZAPHYSEMA) GAUSSOINI Tryon

Plate 3, figs. 1-3; Plate 4; Plate 7, figs. 2, 6

*Helix gaussoini* Tryon 1866, American Journal of Conchology, vol. 2, p. 304, pl. 20, fig. 11 (Navassa Island).

*Helix* (*Coryda*) *gaussoini* Tryon. Pilsbry 1889, Manual of Conchology, ser. 2, vol. 5, p. 47.

*Hemitrochus gaussoini* Tryon. Pilsbry 1889, *ibid.*, ser. 2, vol. 5, p. 197.

*Cepolis (Dialucea) gaussoini* Tryon. Pilsbry 1895, *ibid.*, ser. 2, vol. 9, p. 183.

*Sagda gaussoini* Tryon. Clench 1945. Mollusca, vol. 1, no. 5, p. 65.

*Description.* Shell depressed-globose, reaching 11 mm. in greatest diameter, imperforate, smooth and a light straw-yellow in color. Whorls  $5\frac{1}{2}$ , moderately convex and increasing rapidly, the body whorl being large and somewhat inflated. Suture moderately impressed. Spire depressed and produced at an angle of about  $113^\circ$ . Columella short, slightly thickened, curved and merging into the basal portion of the outer lip. Aperture oval and cast at an angle of  $58^\circ$  from the base. Outer lip thin, simple and not reflected. Inner lip consisting of a very thin glaze on the body whorl. Sculpture consisting only of indistinct growth ridges. Color of shell beneath the periostracum light ivory. Periostracum thin, a light straw-yellow in color and persistent. Columella area white. Embryonic whorls  $1\frac{1}{2}$ , white, smooth and shining.

height	greatest diameter
9	11 mm.
8.5	10

*Type.* The holotype is in the Academy of Natural Sciences, Philadelphia, from Navassa Island, Mr. Eugene Gaussoin, collector.

*Remarks.* Tryon described this species from a single dead specimen, and in his original description related it to *Helix melanocephala* Gundlach from Cuba. Over the years its systematic position has been quite uncertain. As noted in the synonymy above, Pilsbry placed this species in three different groups all belonging in the family Fruticolidae [Cepolidae]. Fortunately the Harvard Expedition found this species alive and collected a large series of them. They were carefully relaxed and preserved so that it has been possible to make a study of the anatomy and so determine its proper systematic position. There is now no question that *gaussoini* belongs in the family Sagdidae; W. J. Clench placed it in the genus *Sagda* on the basis of the shell texture and structure. A study of the reproductive anatomy has shown that it belongs to the genus *Zaphysema* which is also

in the Sagdidae but which until now was not known to occur outside of Jamaica. It was also fortunate that preserved specimens of *Z. tenerrima* C. B. Adams, the type species of *Zaphyscema* Pilsbry, were available for dissection so that comparisons could be made and the figures of both could be published together. The lectotype of *Helix tenerrima* C. B. Adams is figured on Plate 3, figure 6.

The illustrations of the anatomy of the reproductive system of *Z. tenerrima* C. B. Adams from Jamaica given here differ somewhat from that given by Pilsbry (1892, pl. 13, fig. F). However, Pilsbry had only a single specimen and was never able to check his work. He later states that this was one of his first land shell dissections and he obviously was not satisfied with it. So far as I know no other figure of this species has been published. Fortunately, I was able to make dissections of five specimens in all stages of reproduction of which three stages are figured.

The anatomy of the reproductive system of *Z. gaussoini* is very close to that of *Z. tenerrima*. It differs mainly in having a proportionately very much larger penial appendix, in having only three lobes in the ovotestis, in having the penial retractor muscle inserted near the end of the epiphallus fairly close to the opening of the vas deferens rather than near the base as in *tenerrima*. In both species the middle portion of the spermathecal duct is swollen to form a secondary spermatheca. From its side near the apical end arises the slender duct leading to the spermatheca. The spermathecal retractor is inserted very close to the end of the secondary spermatheca. In its normal position the entire spermathecal complex is interwoven with the prostate, uterus, and free oviduct; the spermathecal sac lies at the base of the albumen gland and the retractor muscle is attached to the sheath of the gland. In young or non-breeding specimens the penial appendix lies above the entire visceral mass and can be clearly seen through the body wall when the mantle is removed. In specimens full of eggs or young snails the appendix is pushed inward and the greatly enlarged uterus comes to lie on top of it. In one of the specimens of *tenerrima* dissected, the uterus was distended with 53 fully developed eggs with white, calcareous shells. The specimen figured in Plate 6, figure 1 contained over